TERMINAL LEARNING OBJECTIVE

ACTION

Troubleshoot arithmetic units

CONDITION

Given a classroom environment, Computer Aided Instruction (CAI) workstation, NIDA 130 Electron
Trainer, Digital Multimeter w/test leads, Digital Logic Probe, PC130-111, PC130-116, PC130-12
PC130-131, and official OMEMS reference material.

STANDARD

Correctly answer 18 of 25 questions concerning arithmetic units.

CLASSIFICATION:	UNCLASSFIED
SAFETY CONSIDERATIONS:	ELECTRICAL SHOCK HAZARD
	ELECTOSTATIC DISCHARGE
ENVIRONMENTAL:	NONE
RISK ASSESMENT:	LOW

ENABLING LEARNING OBJECTIVE 1

ACTION

Describe the purpose and operation of Up and Down counters

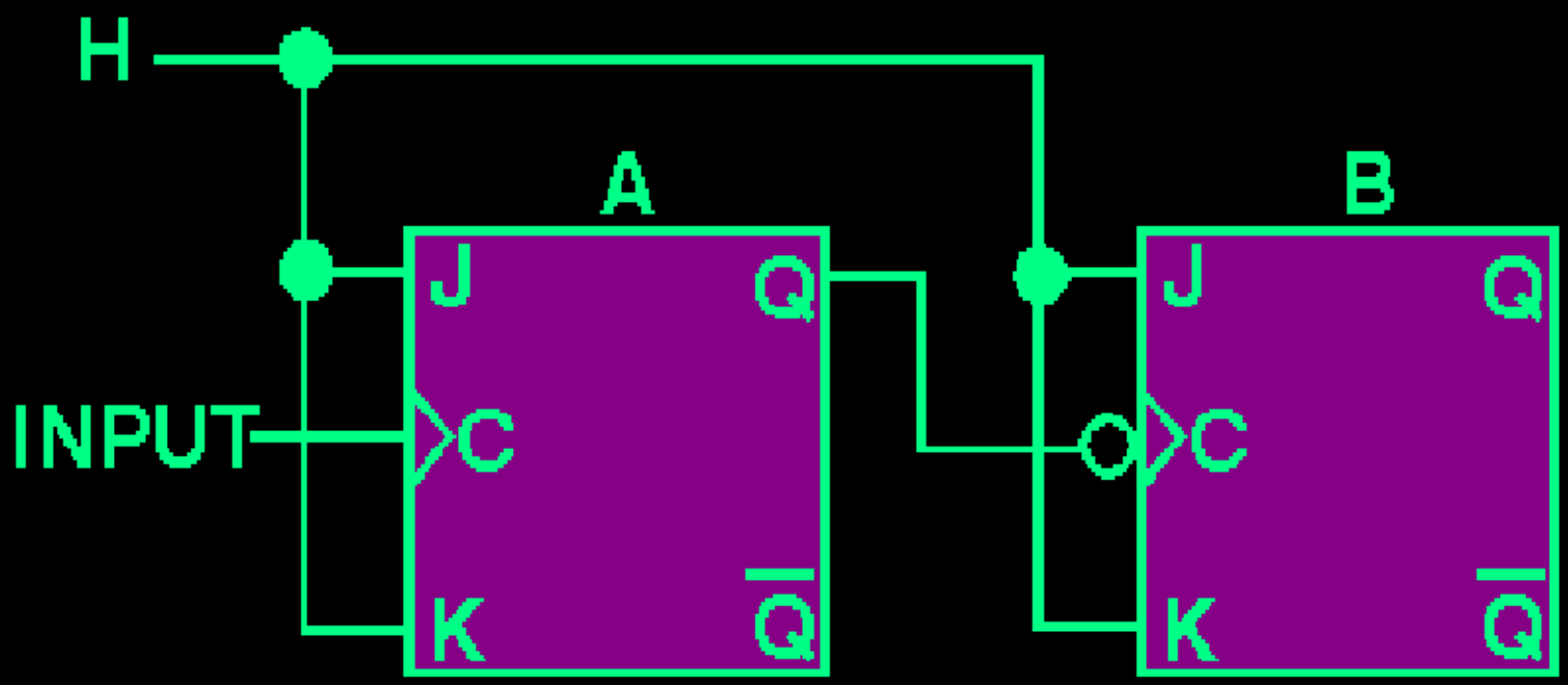
CONDITION

Given a classroom environment, Computer Aided Instruction (CAI) workstation, NIDA 130 Electronic Trainer, Digital Multimeter w/test leads, Digital Logic Probe, PC130-111, PC130-116, PC130-121, PC130-131, and official OMEMS reference material.

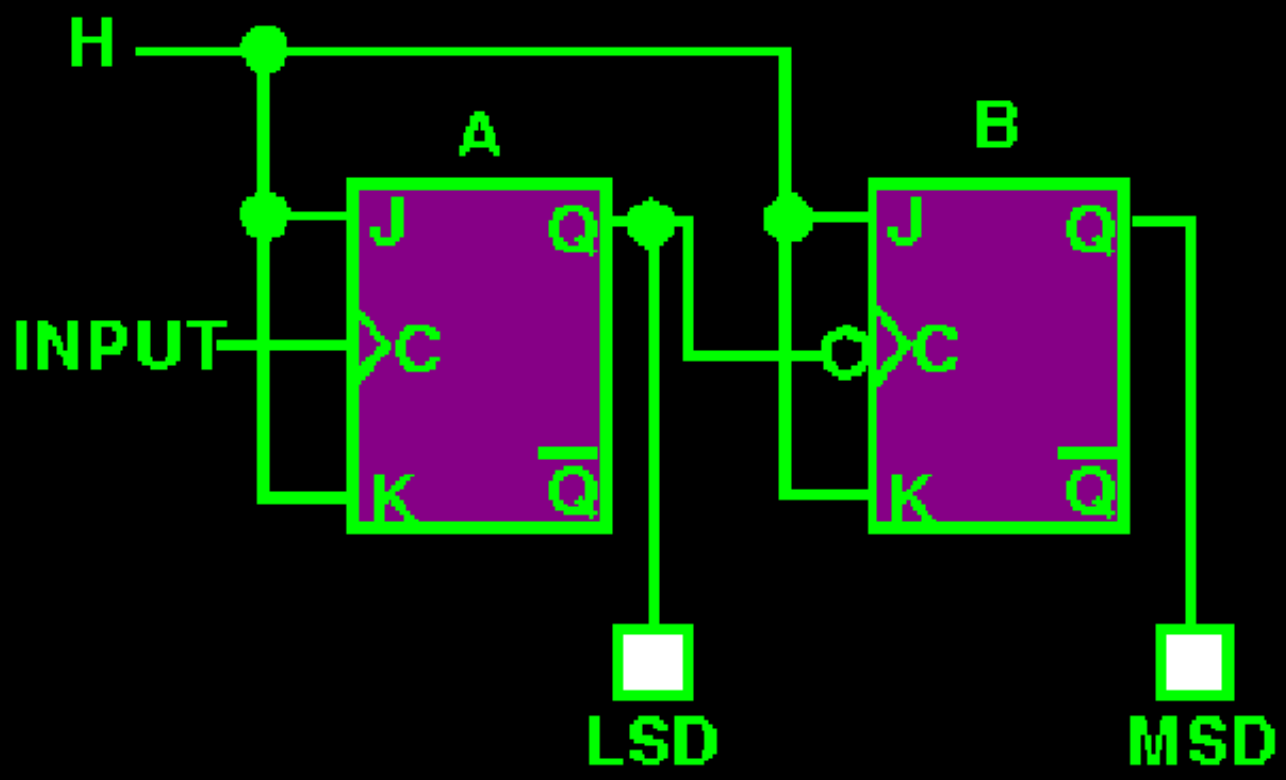
STANDARD

Correctly answer 18 of 25 questions concerning arithmetic units.

COUNTER	Used to perform counting operations.
ADDER	Used to determine the sum of two binary numbers.
SUBTRACTOR	Uses an adder to subtract two binary numbers.

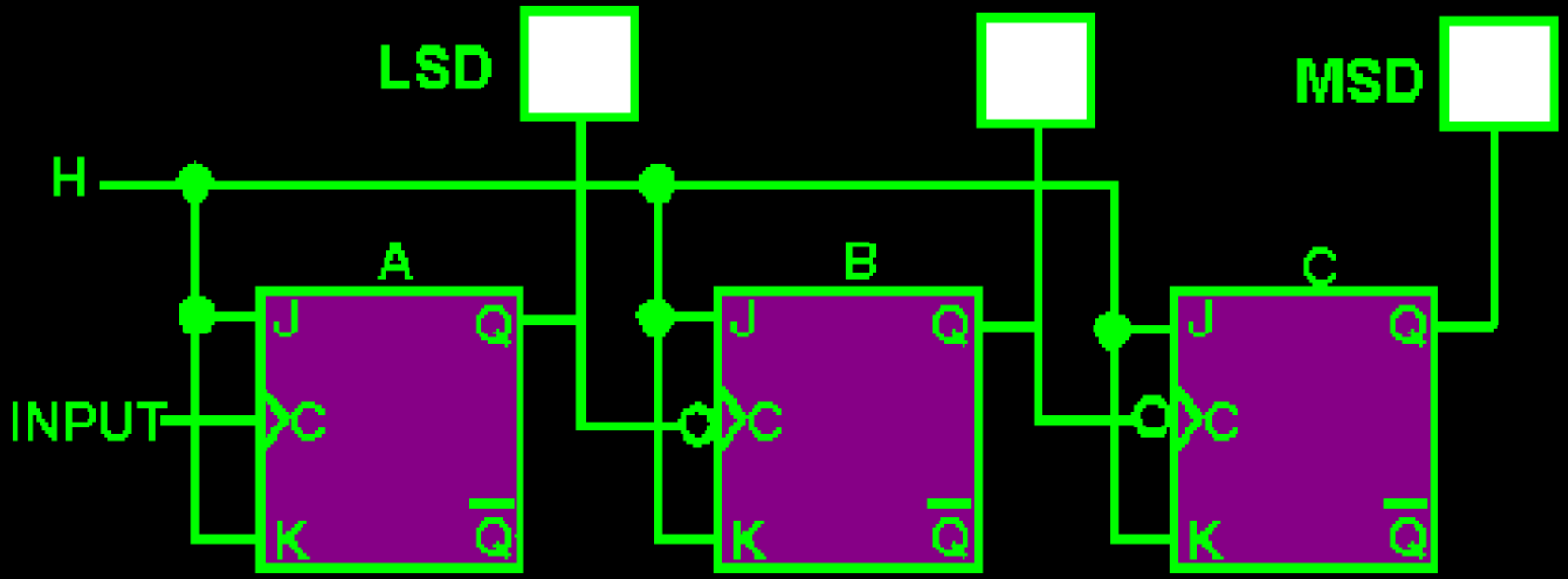


COUNTER CONSTRUCTION AND MODE OF OPERATION

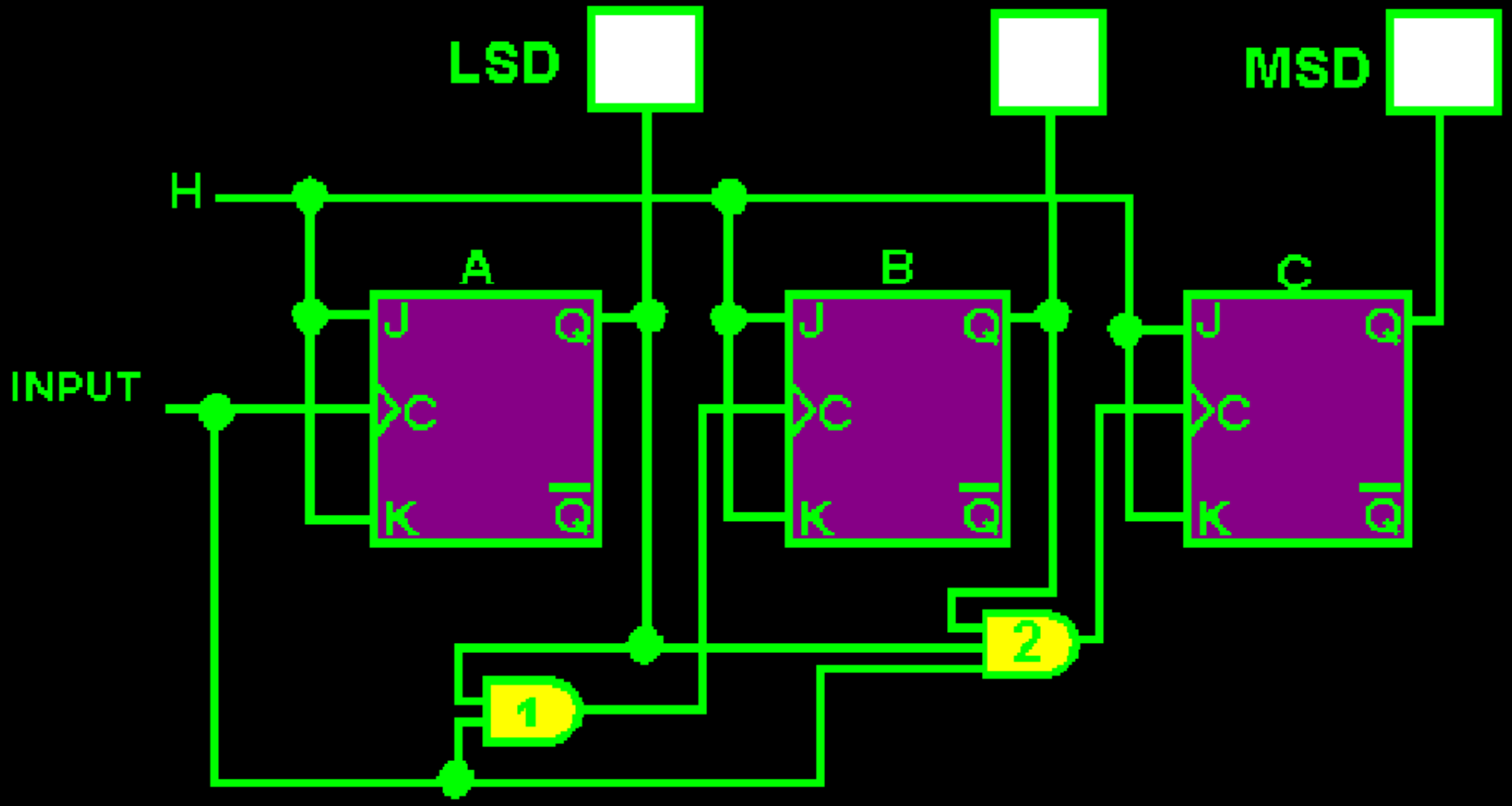


PULSE	QB	QA
0	0	0
1	0	1
2	1	0
3	1	1
4	0	0

MODULUS 4 UP COUNTER



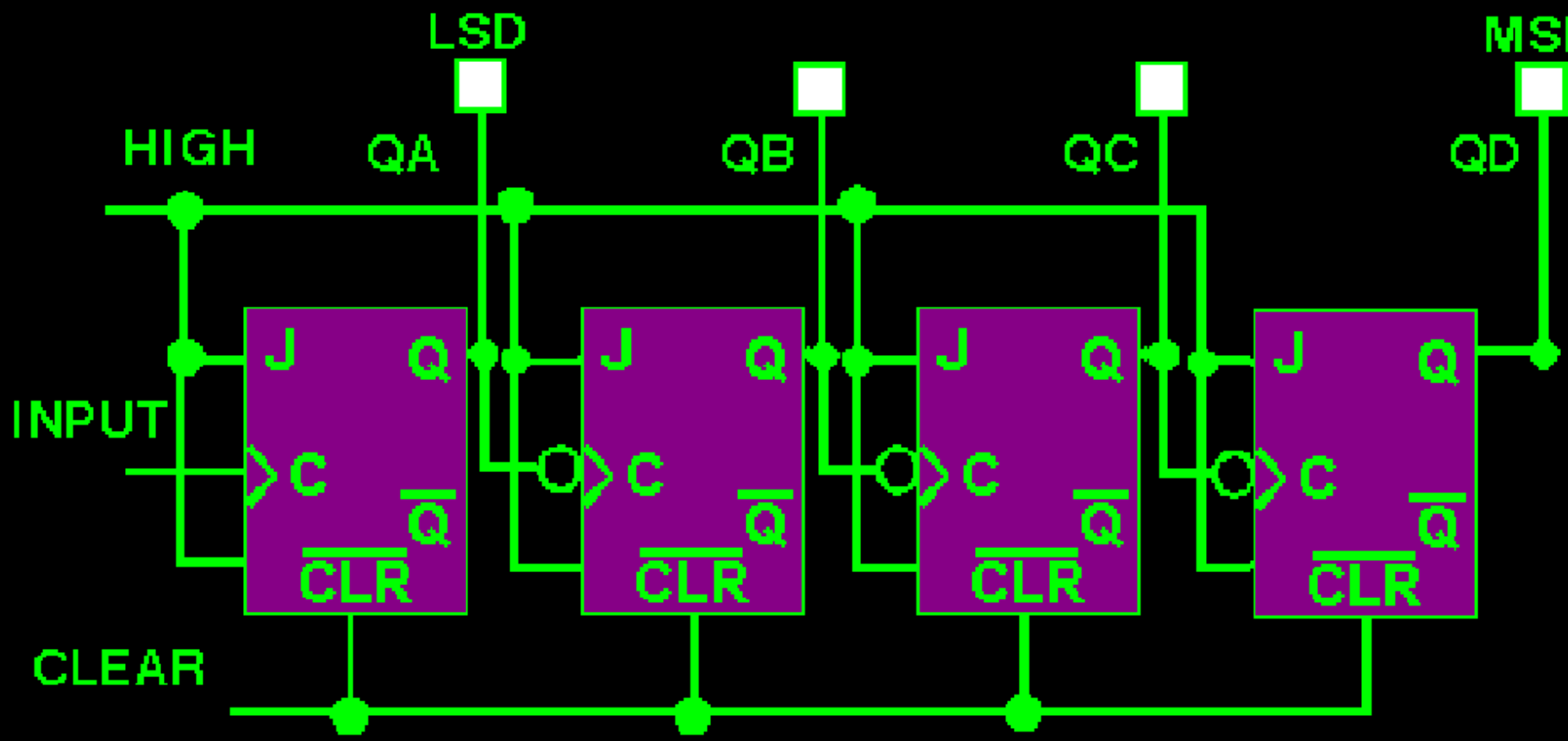
ASYNCHRONOUS UP COUNTER



SYNCHRONOUS UP COUNTER

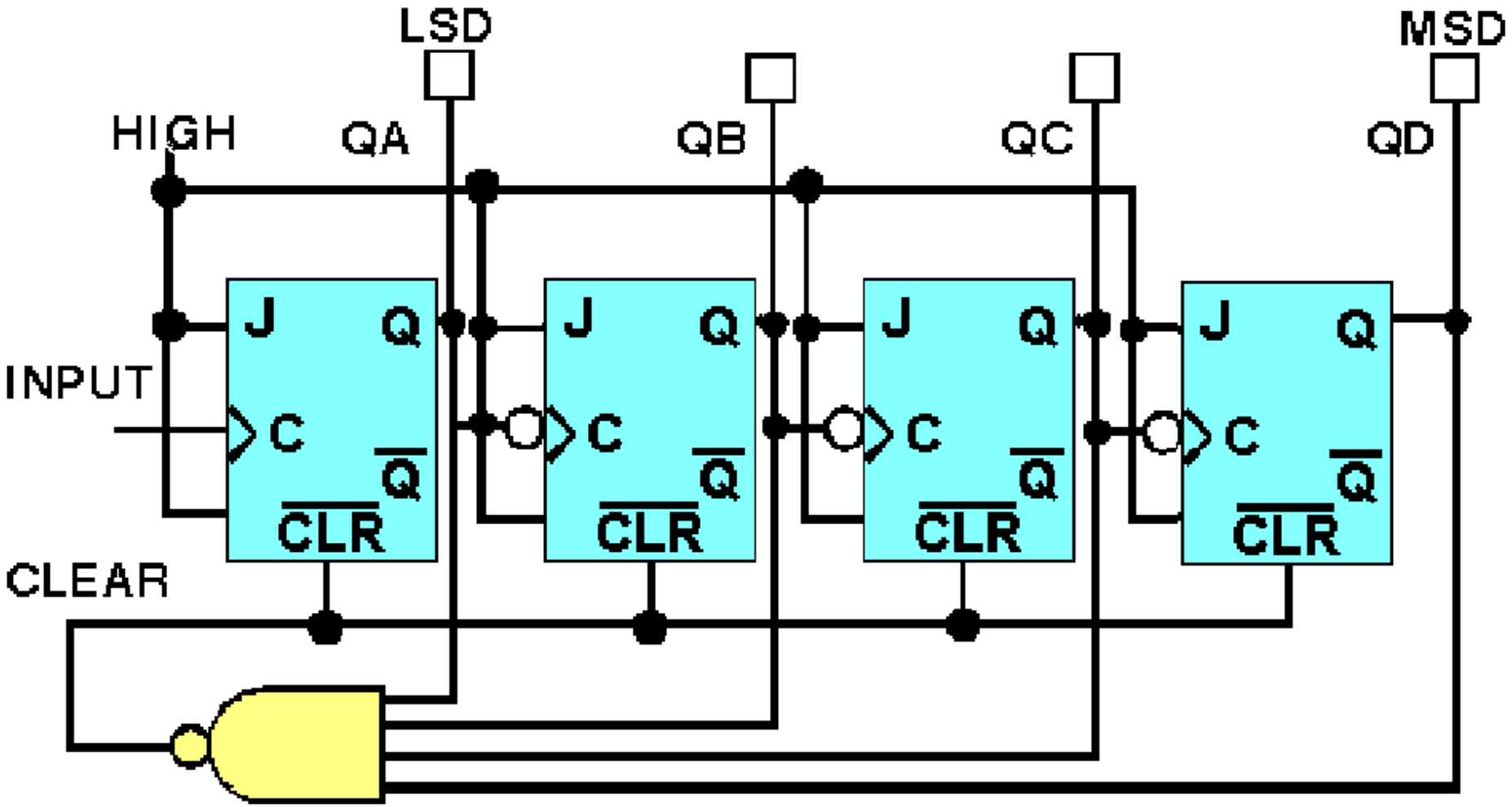
RIPPLE COUNTER

AN ASYNCHRONOUS COUNTER DESIGN TO COUNT PULSES IN BINARY, AND TO OPERATE AT VARIOUS MODULUS BY USING A CLEAR PULSE.



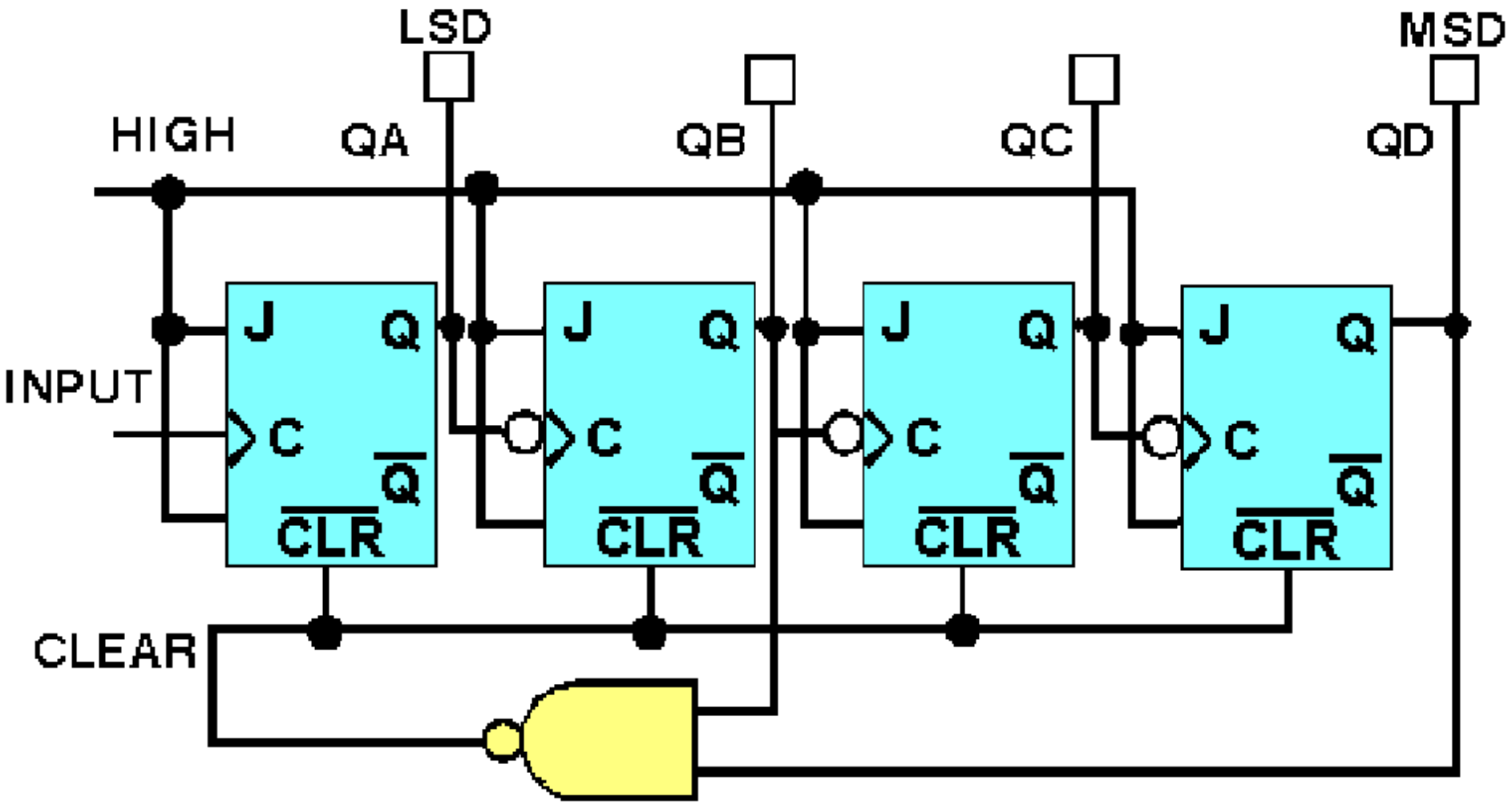
MOD 16 RIPPLE COUNTER

EL15-S08



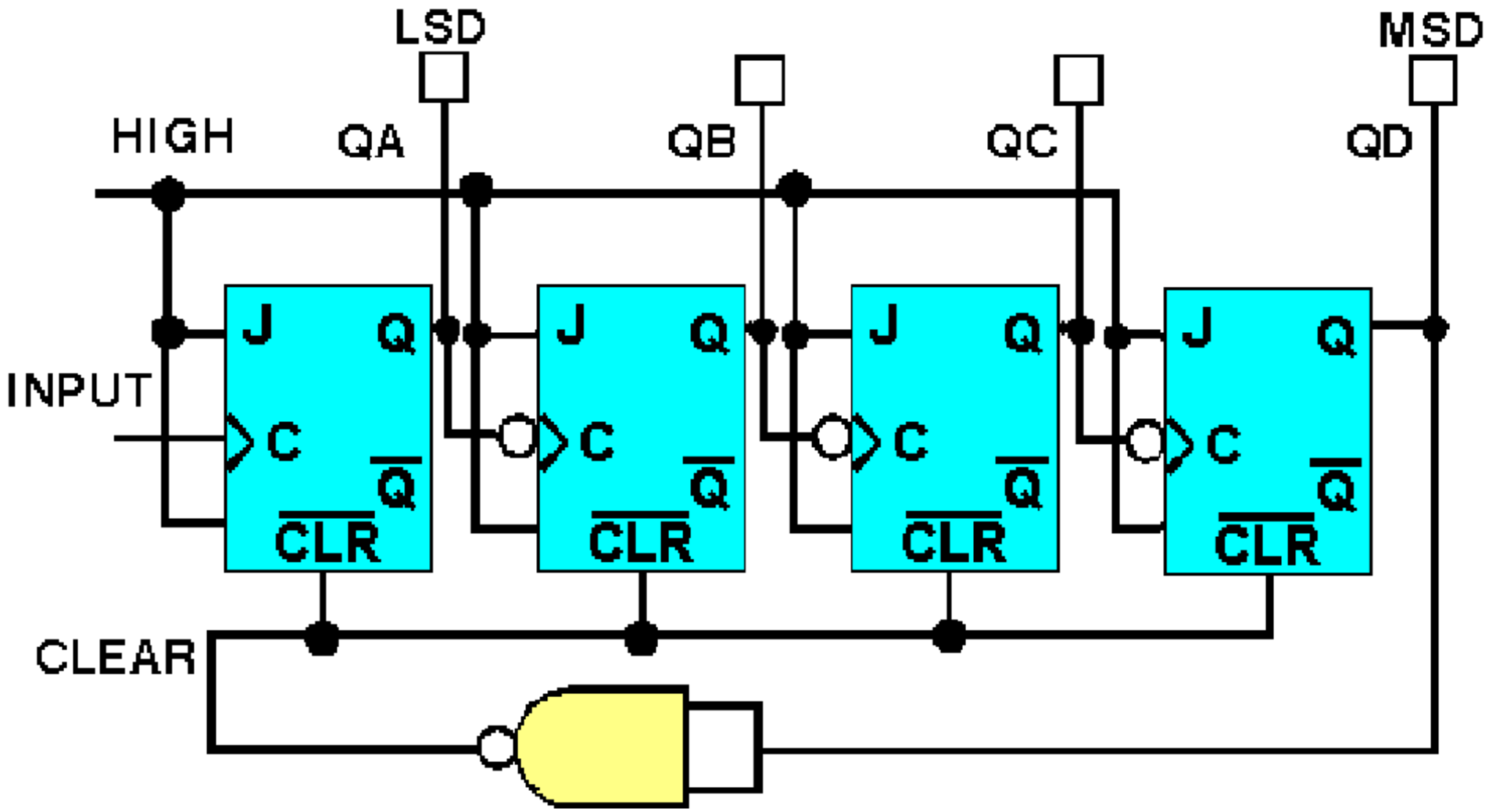
MOD 15 RIPPLE UP COUNTER

EL15-S09



MOD10 RIPPLE UP COUNTER

EL15-S10



MOD 8 RIPPLE UP COUNTER

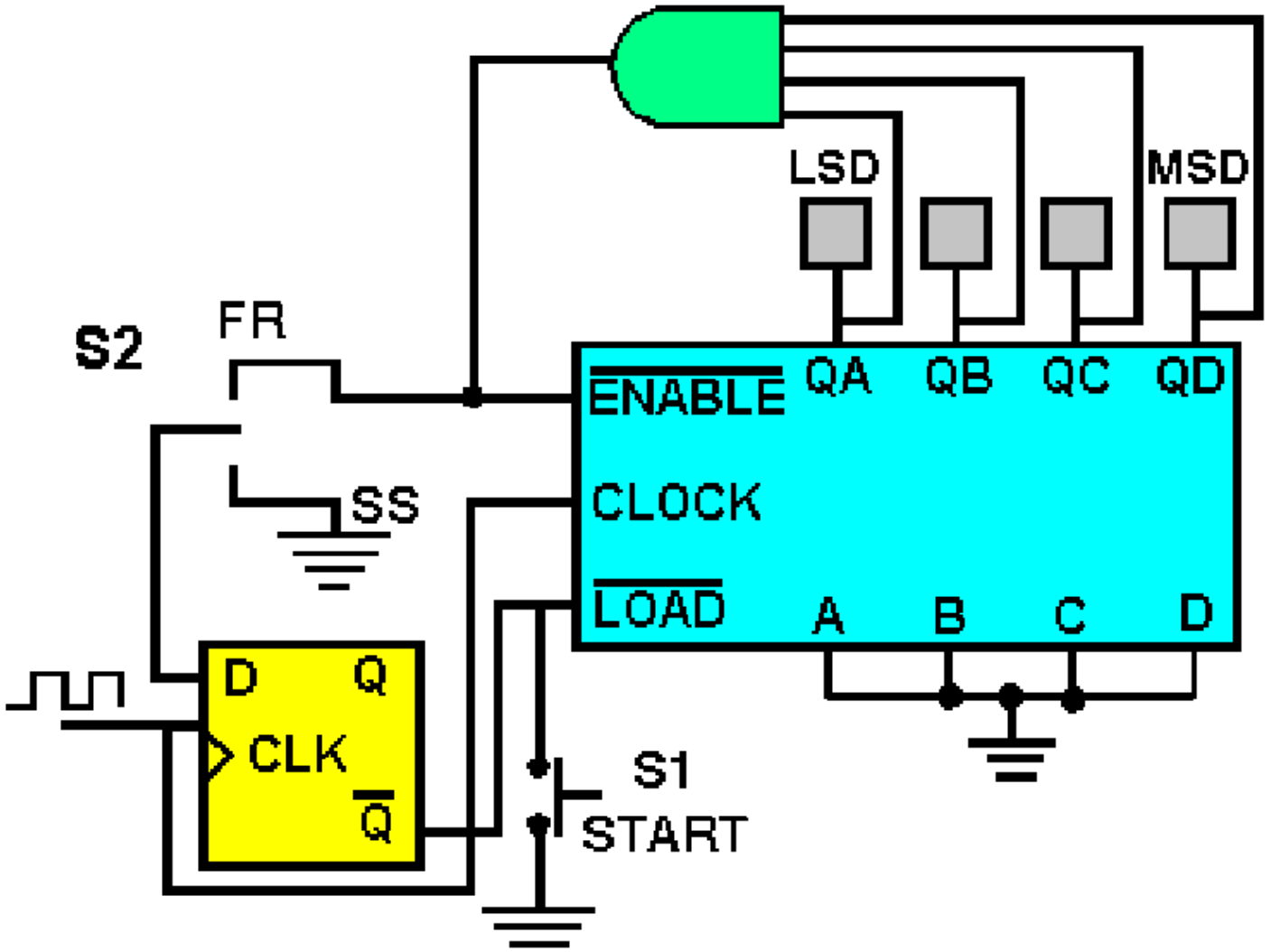
EL15-S11

UP COUNTER

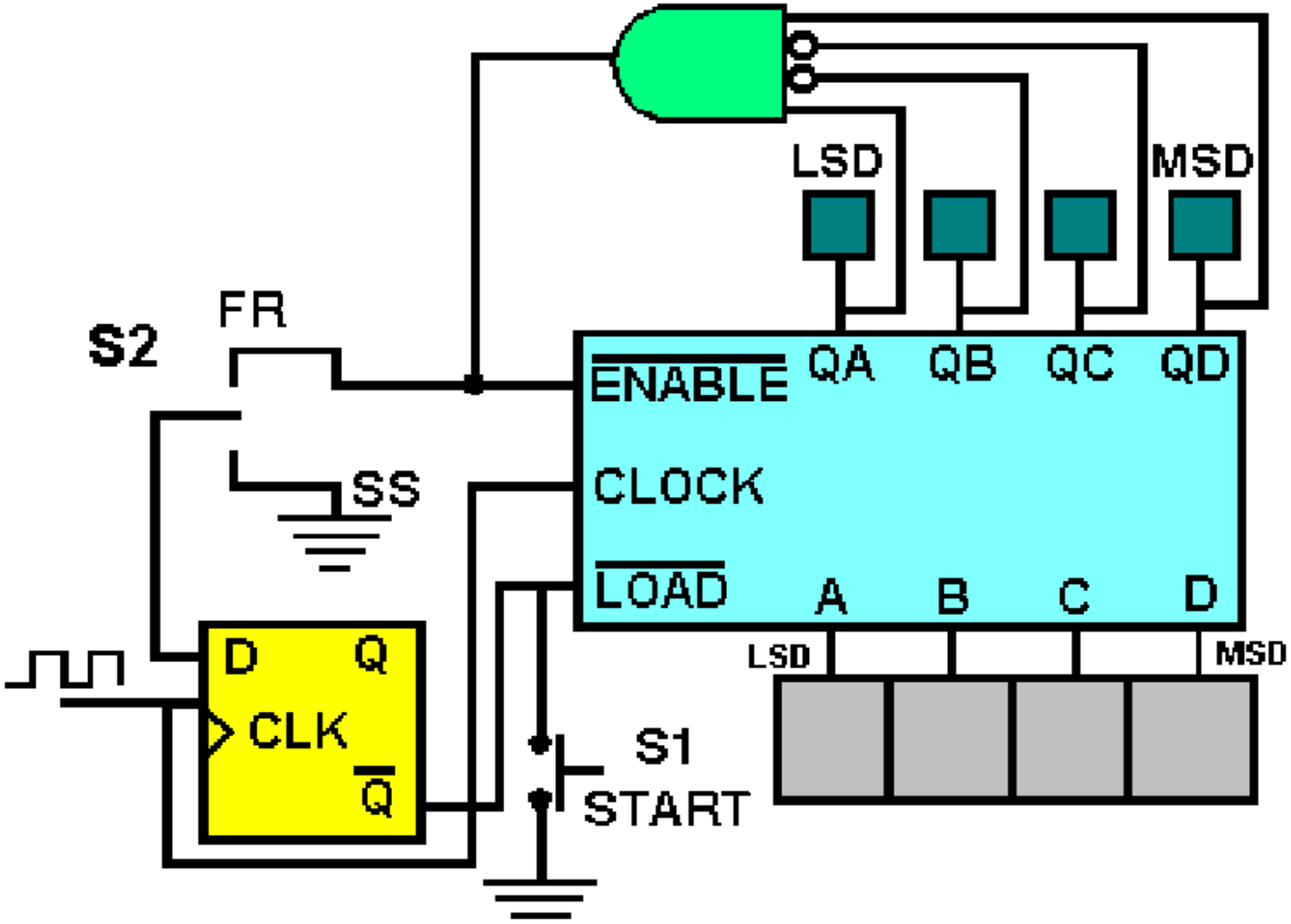
A SYNCHRONOUS COUNTER DESIGN TO COUNT UP IN BINARY AND TO OPERATE IN FREE RUN AND SINGLE STEP MODES.

DOWN COUNTER

A SYNCHRONOUS COUNTER DESIGN TO COUNT DOWN IN BINARY AND TO OPERATE IN FREE RUN AND SINGLE STEP MODES.

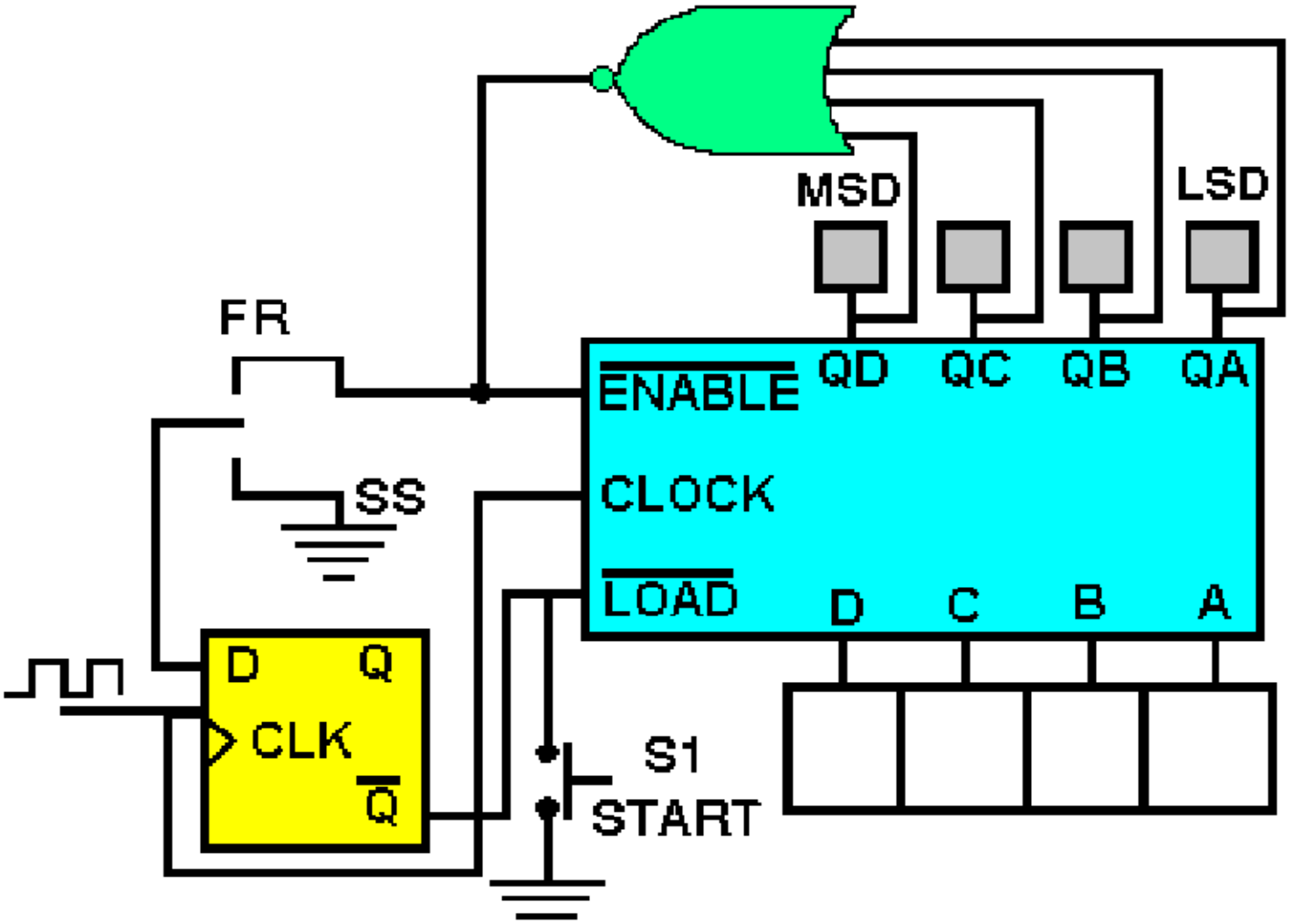


UP COUNTER MODES OF OPERATION



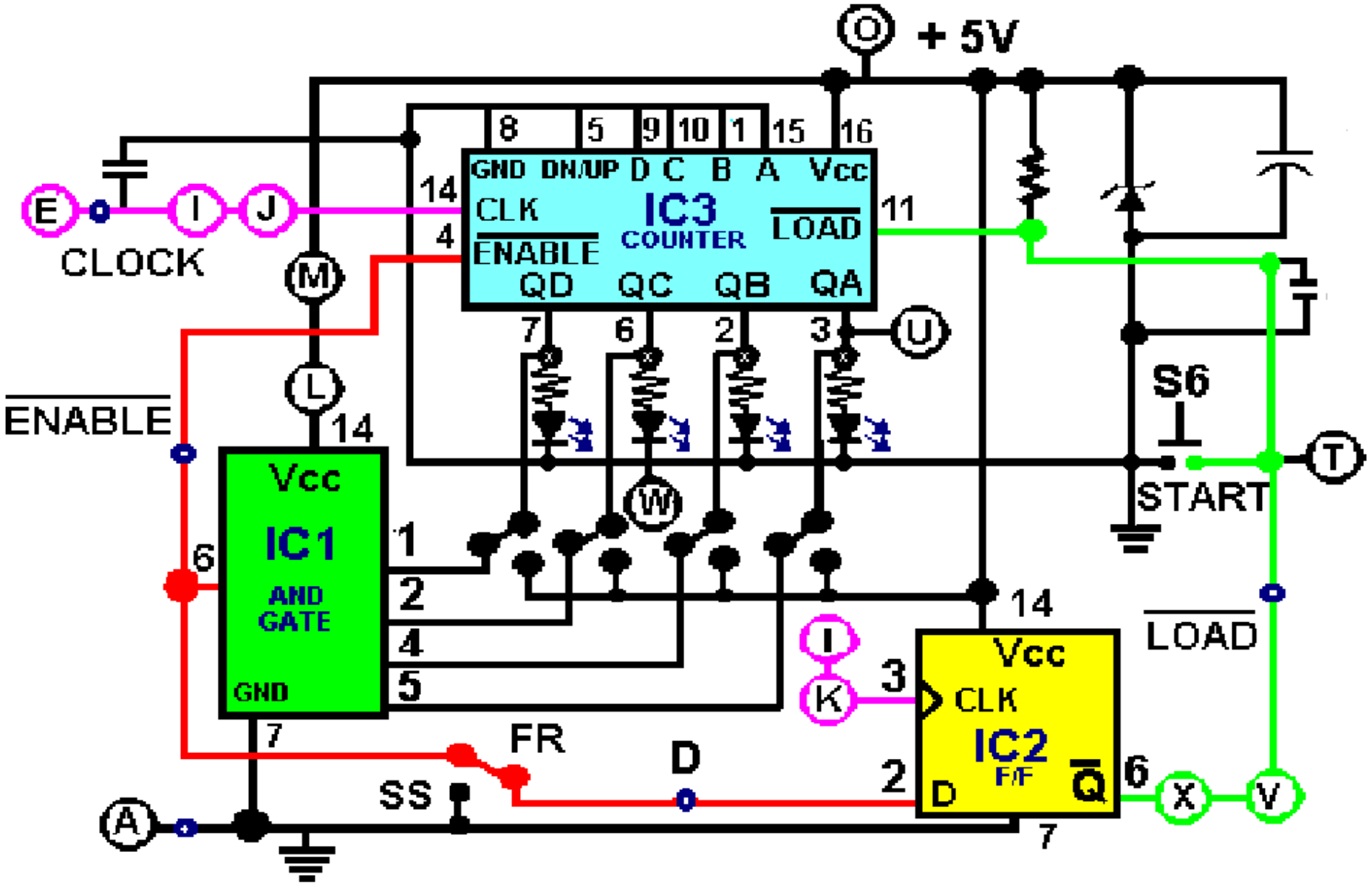
VARIABLE MODULUS UP COUNTER

EL15-S14



DOWN COUNTER MODES OF OPERATION

EL15-S15


O
+ 5V
8
5
9
10
1
15
16
GND DN/UP D C B A Vcc
CLK
IC3
COUNTER
LOAD
ENABLE
QD QC QB QA
14
4
11
E
I
J
CLOCK
M
L
U
7
6
2
3
S6
T
START
ENABLE
14
Vcc
IC1
AND
GATE
GND
6
1
2
4
5
W
14
I
K
3
Vcc
CLK
IC2
F/F
D
Q
2
6
7
LOAD
X
V
FR
D
SS
A
7

EL15-S16

What mode allows the down counter to count down to 0 from the maximum count and start over ?

1. Single step
2. Decrement
3. MOD 16
4. Free run

What determines the modulus of a counter ?

1. The number of inputs
2. The number of outputs
3. The number of flip-flops
4. The number of clock pulses

What mode allows an up counter to count to the maximum count and then stop ?

1. Single step
2. Increment
3. Free run
4. MOD 16

What signal places parallel inputs A, B, C, and D into the up counter ?

1. CLOCK
2. DN/UP
3. $\overline{\text{ENABLE}}$
4. $\overline{\text{LOAD}}$

What input is used in a ripple counter to reset the count in various MODs ?

1. $\overline{PRE}$
2. $\overline{CLR}$
3. J
4. K

A counter is a circuit that

1. is connected to an adder for subtraction.
2. is connected to a memory for addressing.
3. performs counting in decimal.
4. performs counting in binary.

ENABLING LEARNING OBJECTIVE 2

ACTION

Describe the purpose and operation of Adder and Subtractor circuits.

CONDITION

Given a classroom environment, Computer Aided Instruction (CAI) workstation, NIDA 130 Electronic Trainer, Digital Multimeter w/test leads, Digital Logic Probe, PC130-111, PC130-116, PC130-121, PC130-131, and official OMEMS reference material.

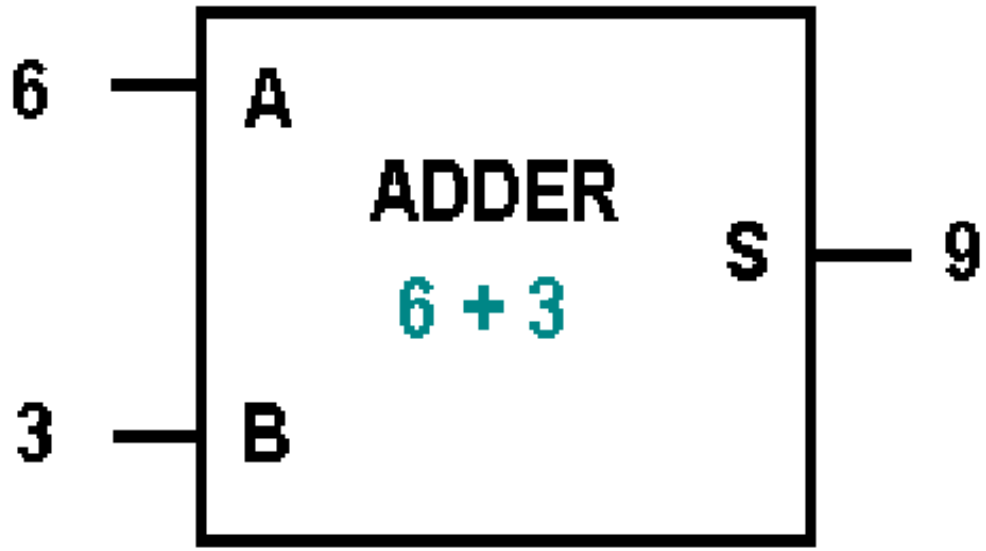
STANDARD

Correctly answer 18 of 25 questions concerning arithmetic units.

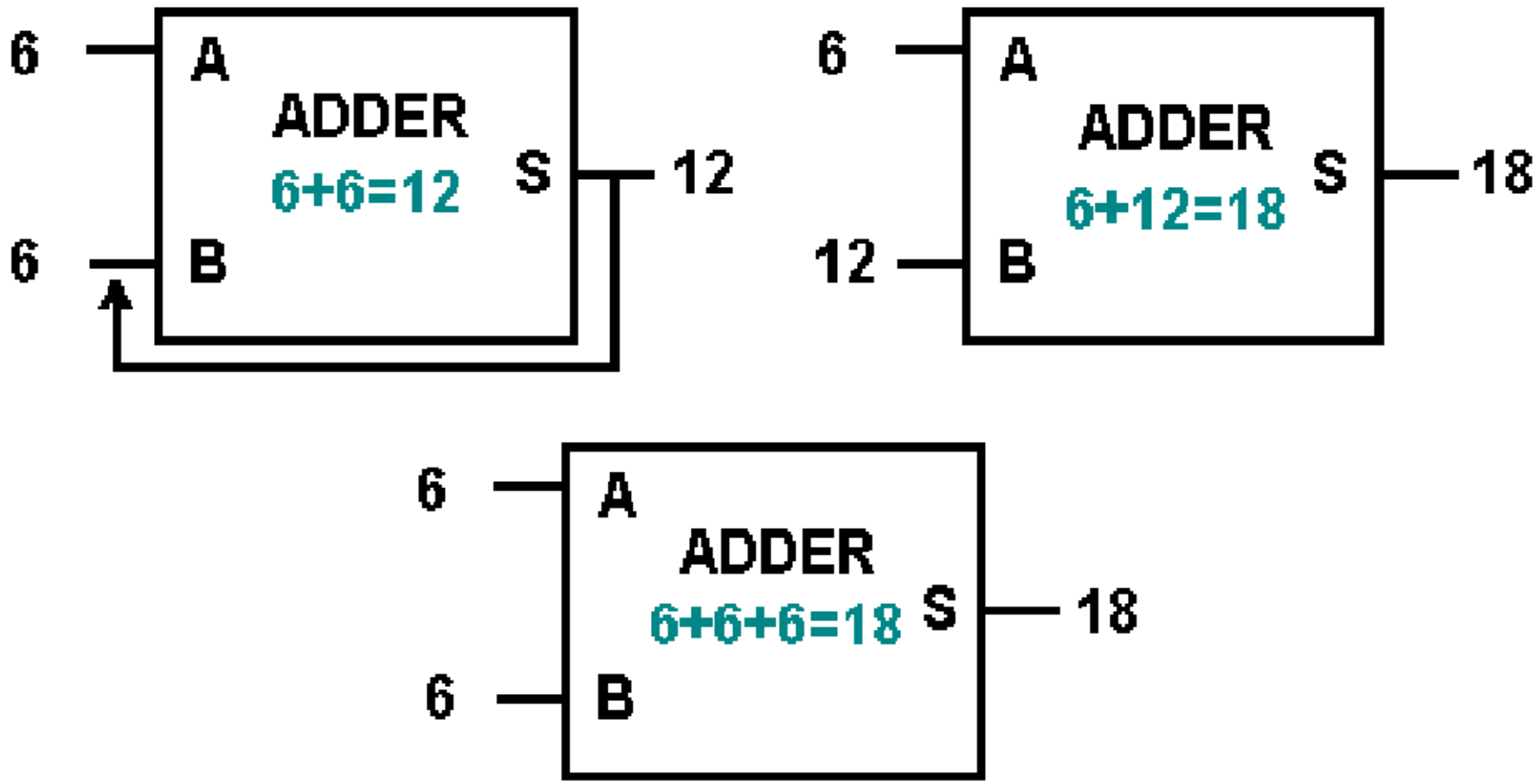
ADDER PERFORMS

* ADDITION
* MULTIPLICATION
* SUBTRACTION
* DIVISION

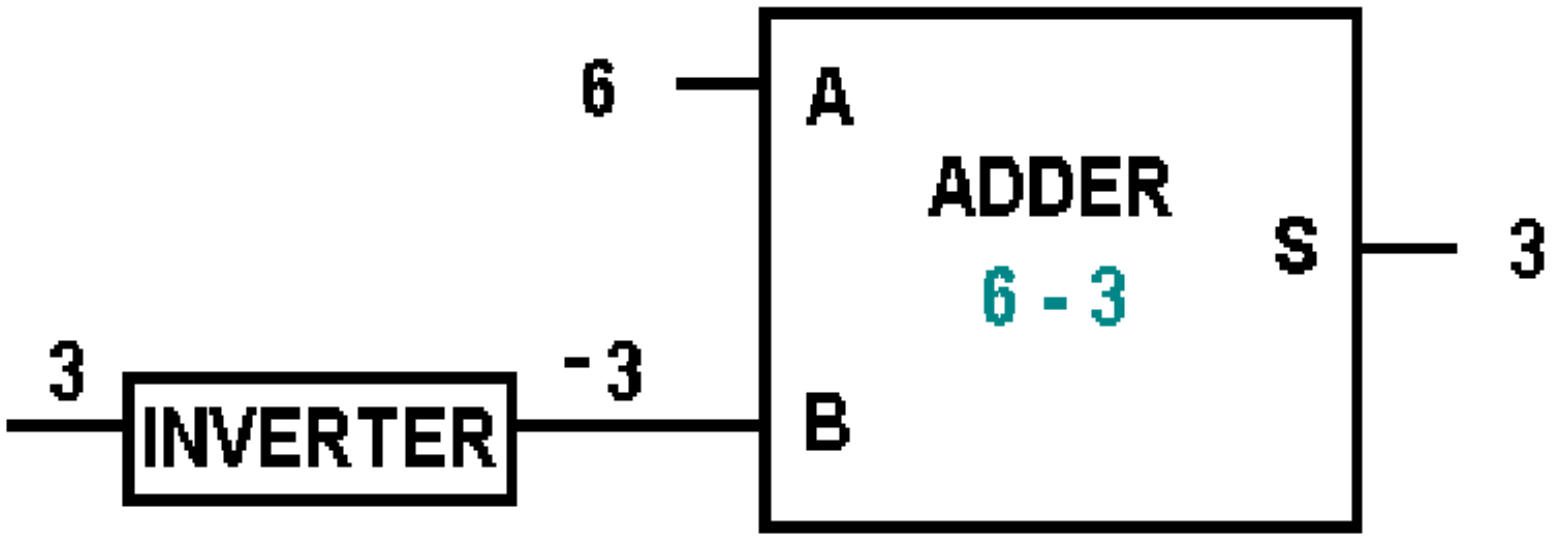
Addition - Two numbers are applied to the Adder circuit. The numbers are added together.



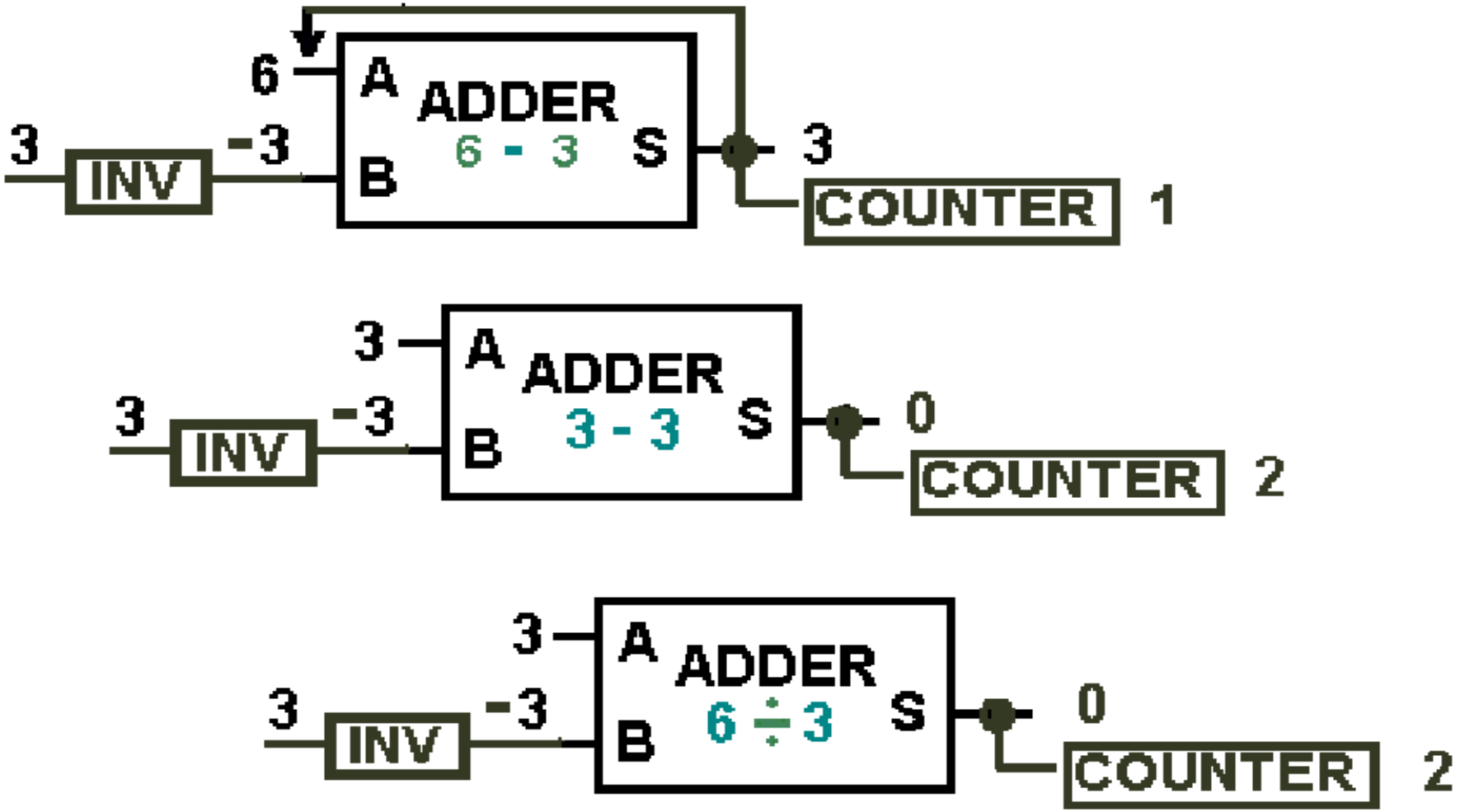
Multiplication - A series of additions. The result of the first addition is fed back to input B where it is added to 6. 6 x 3 = 6+6+6

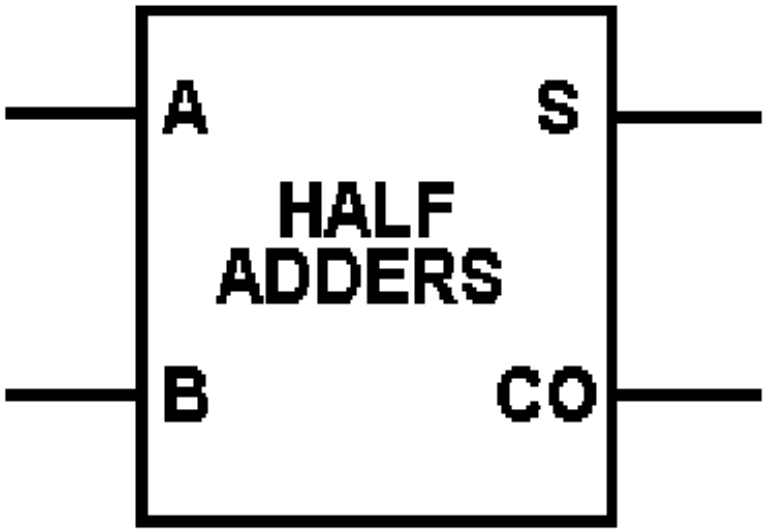


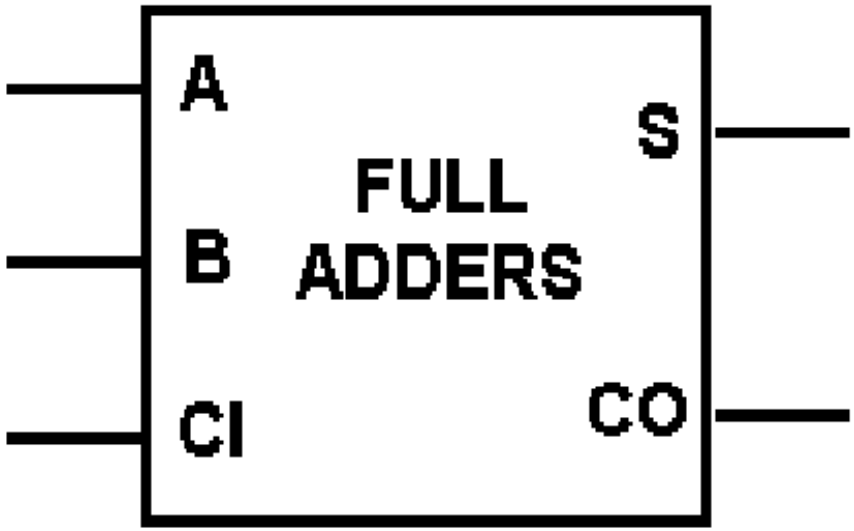
Subtraction - Is adding a negative number or a number that is inverted. 6 - 3 = 6 + (-3)

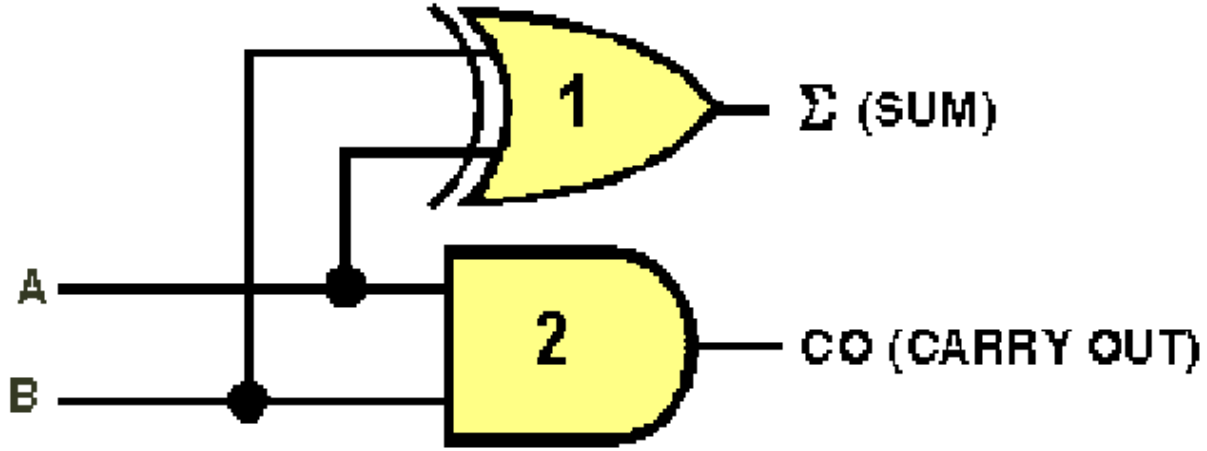


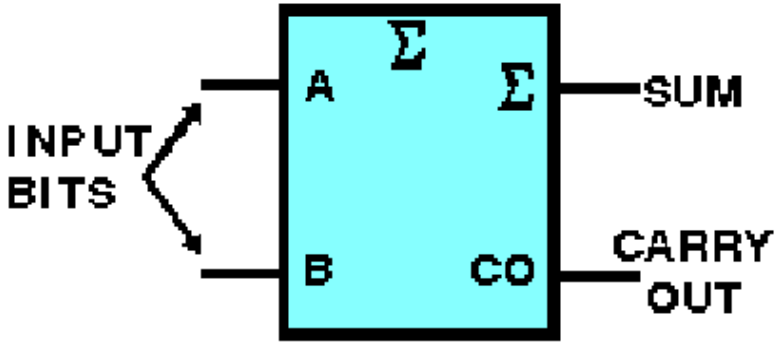
Division - Is a series of subractions. The number of times the counter has to subtract to reach zero is the results.




A
S
HALF
ADDERS
B
CO

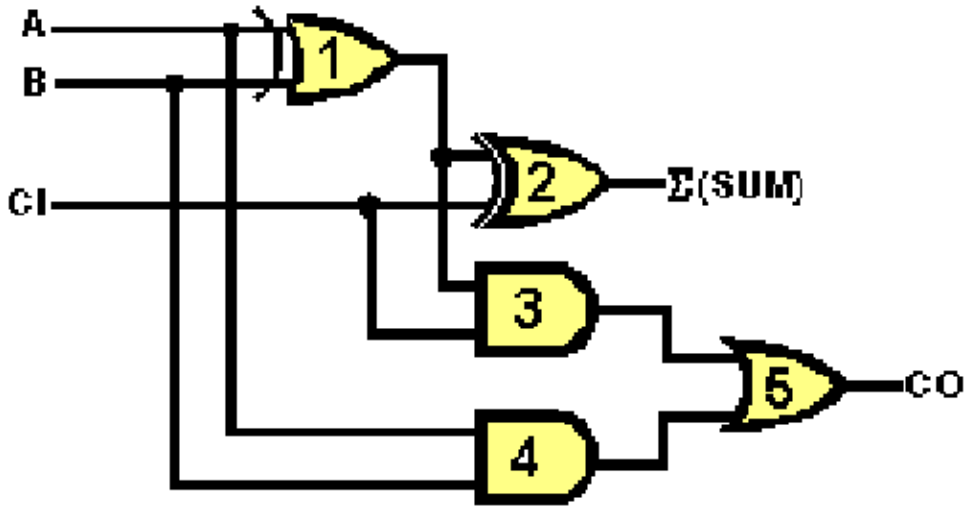

A
S
FULL
B
ADDERS
CI
CO

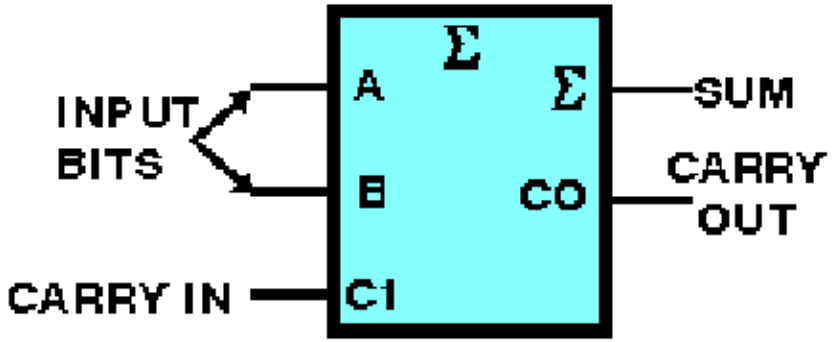




A	B	CO	Σ
0	0	0	0
0	1	0	1
1	0	0	1
1	1	1	0

Half Adder Gate Logic, Schematic Symbol and Truth Table



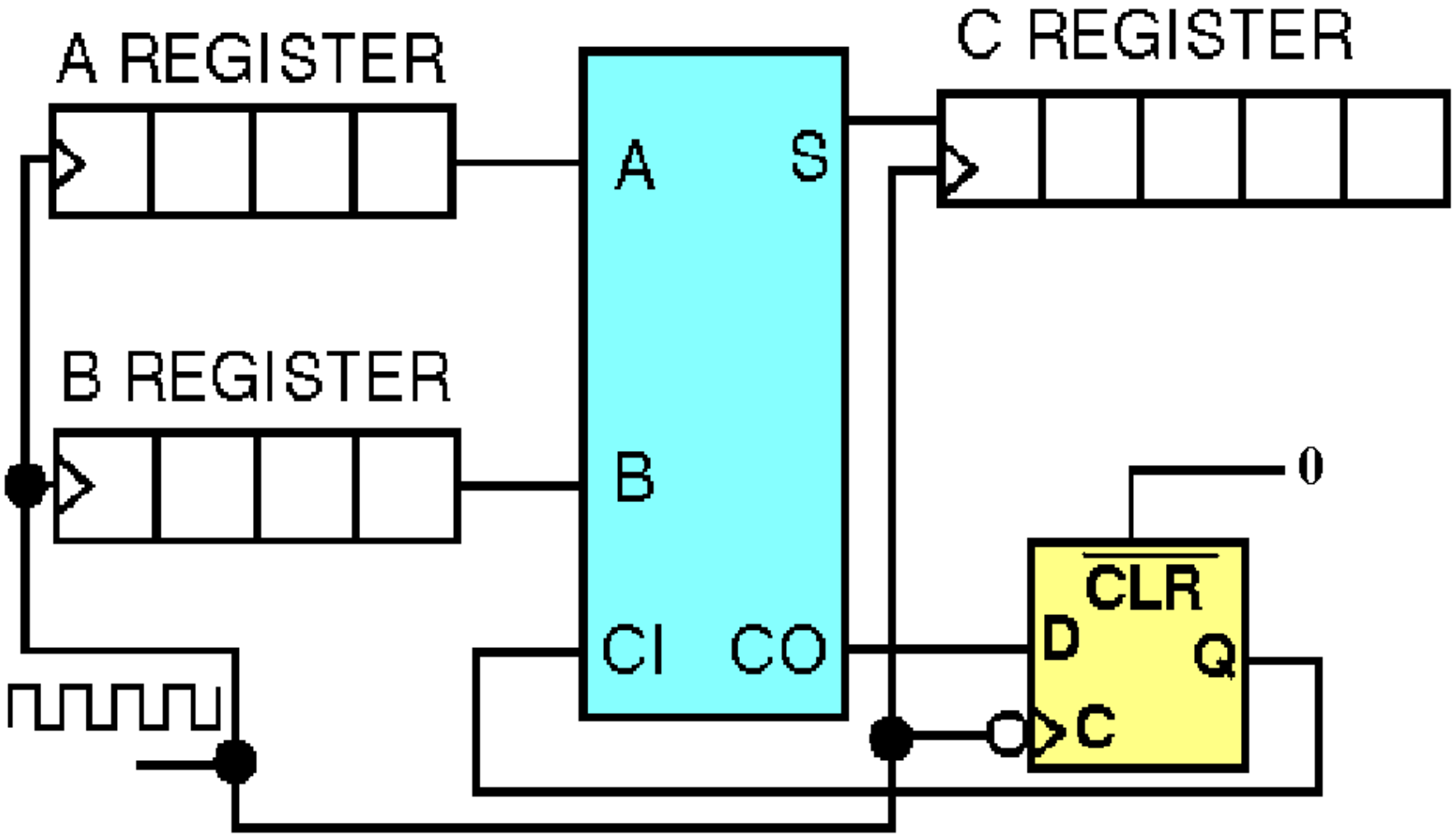


A	B	C1	CO	Σ
0	0	0	0	0
0	0	1	0	1
0	1	0	0	1
0	1	1	1	0
1	0	0	0	1
1	0	1	1	0
1	1	0	1	0
1	1	1	1	1

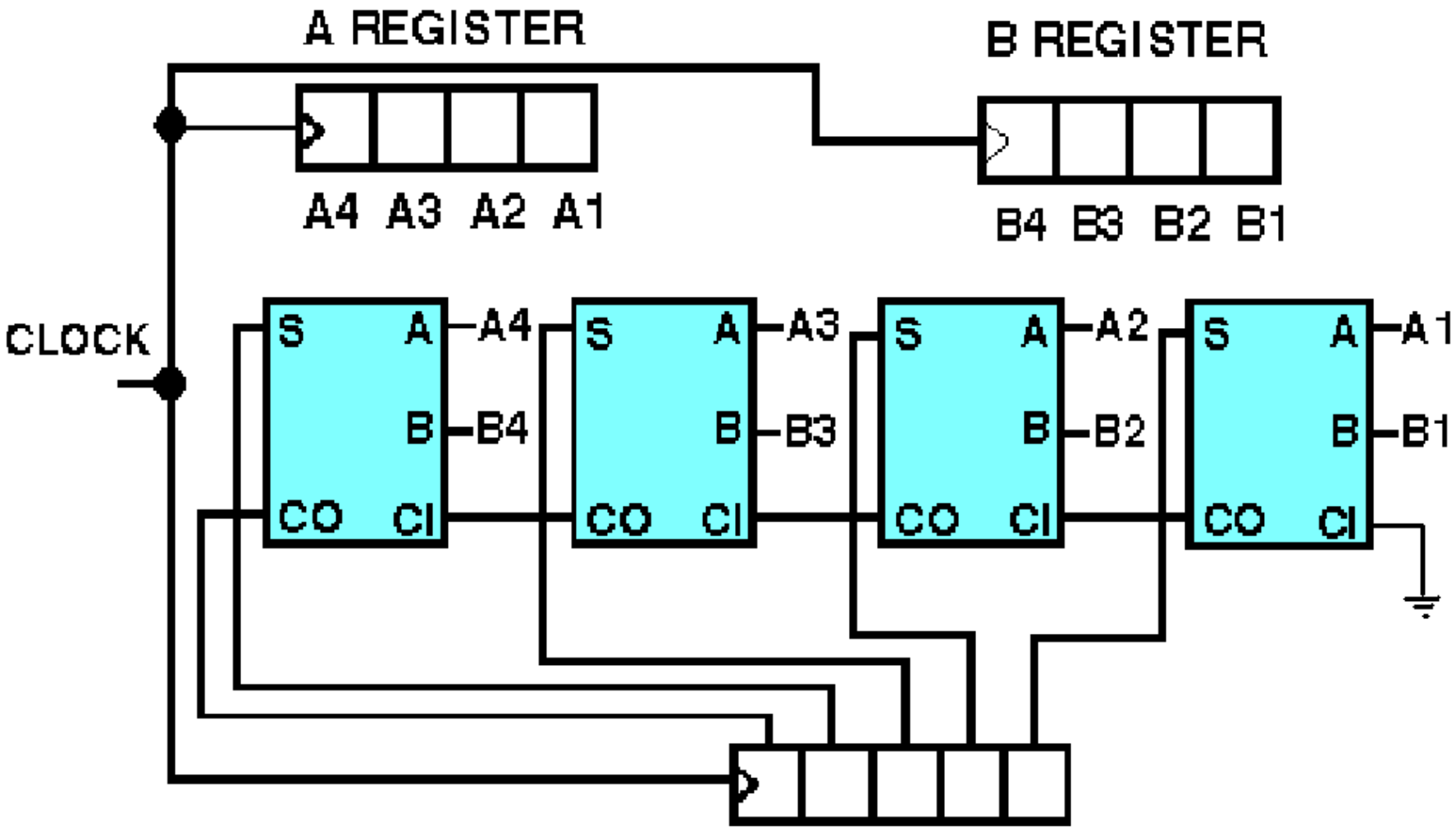
Full Adder Gate Logic, Schematic Symbol and Truth Table

4 BIT SERIAL & PARALLEL ADDERS

4 BIT SERIAL & PARALLEL SUBTRACTORS

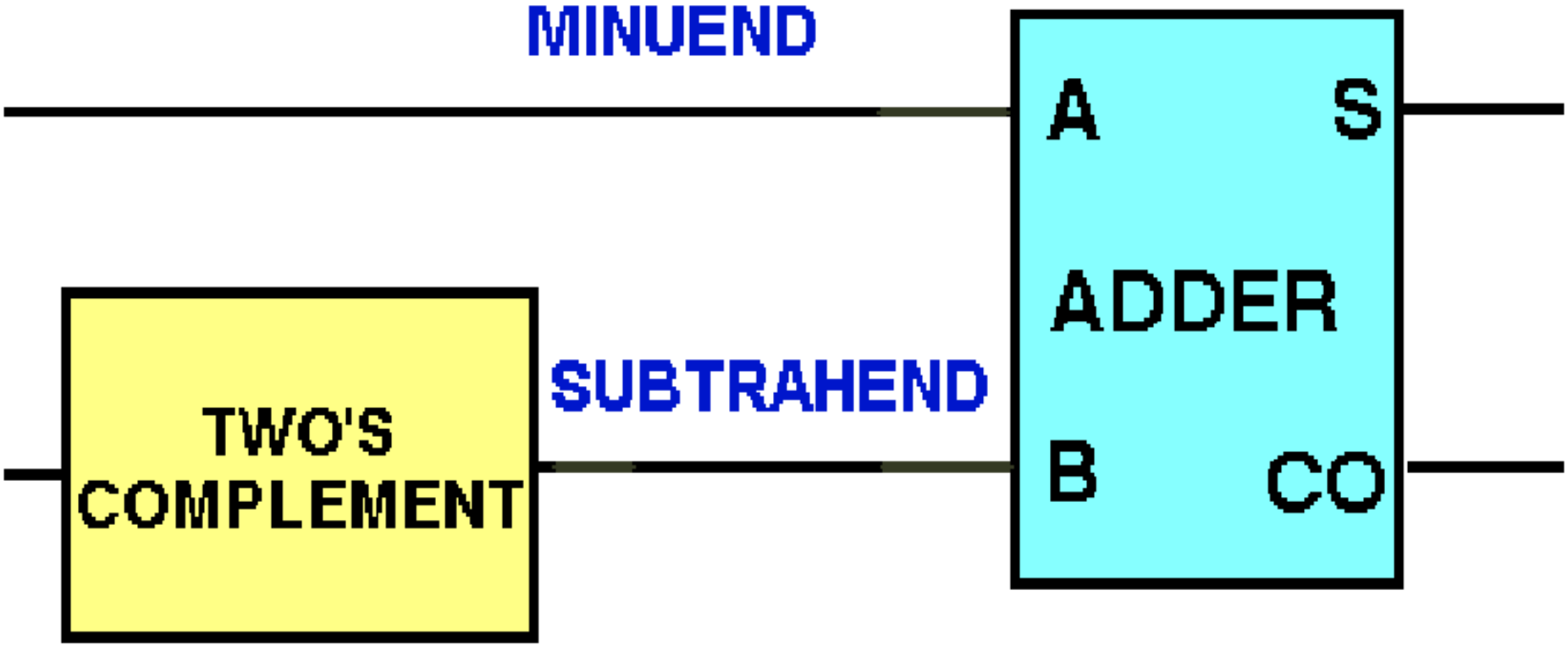


4 BIT SERIAL ADDER

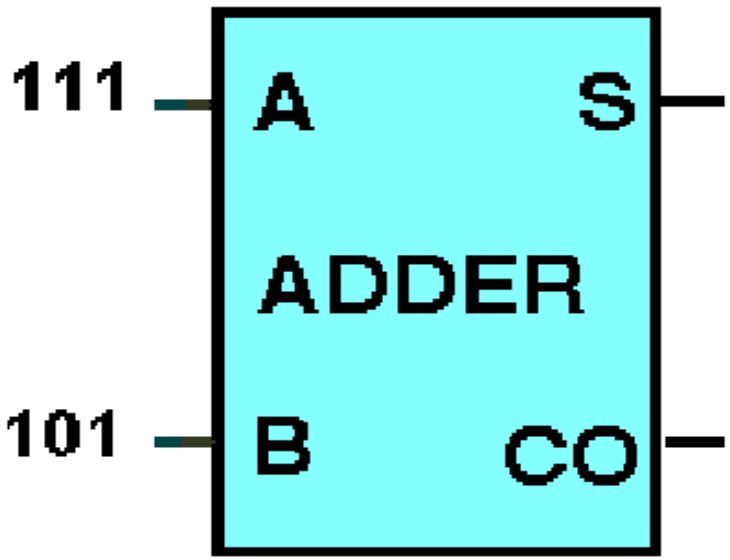


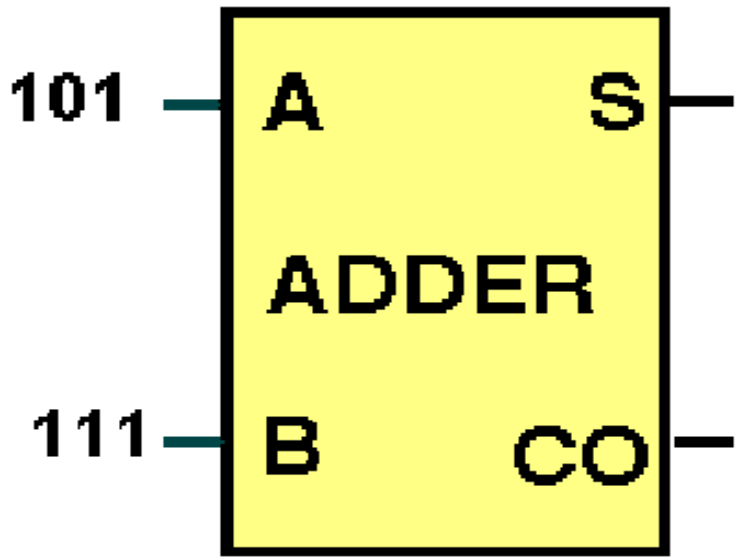
4 BIT PARALLEL ADDER

EL15-S27

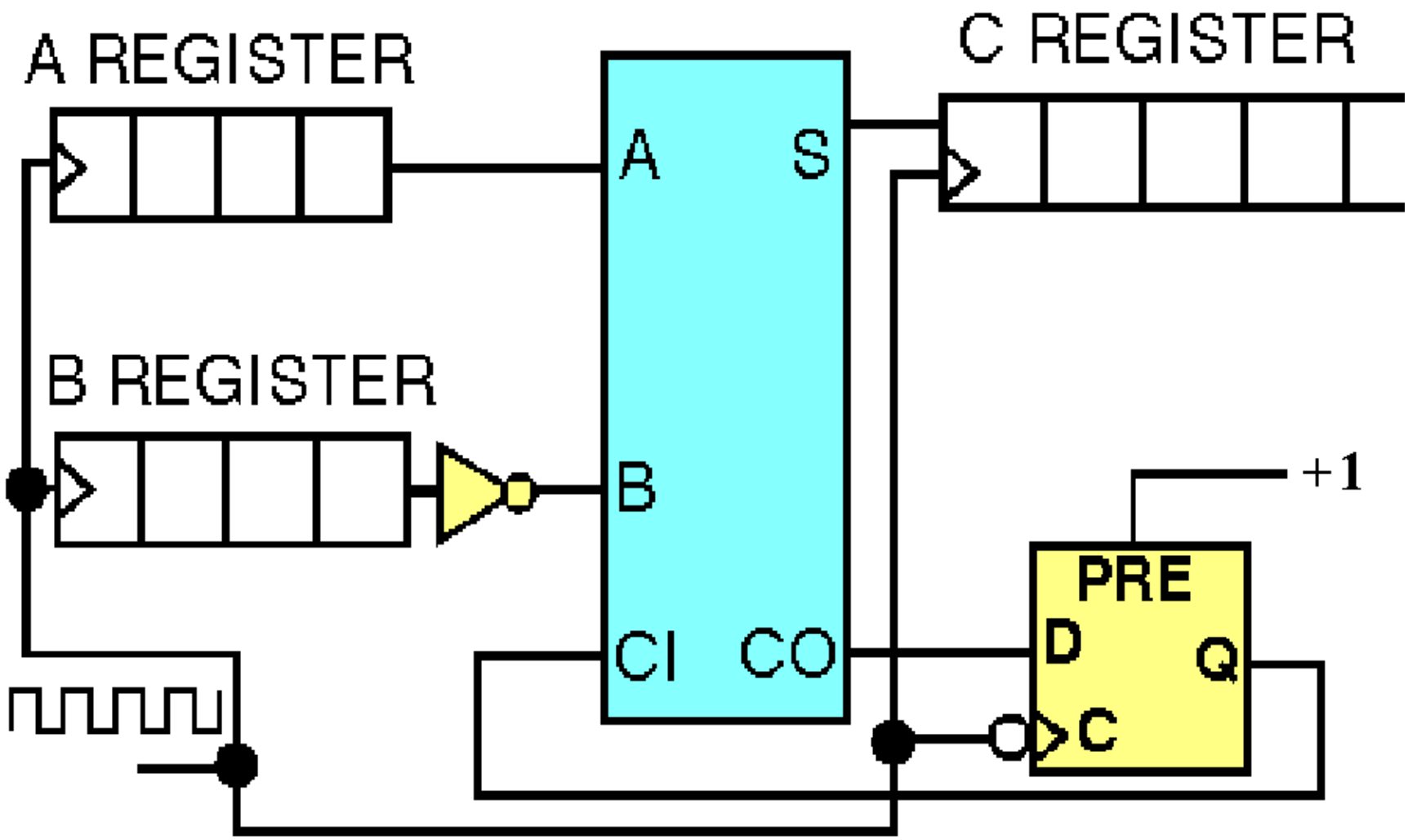


SUBTRACTOR

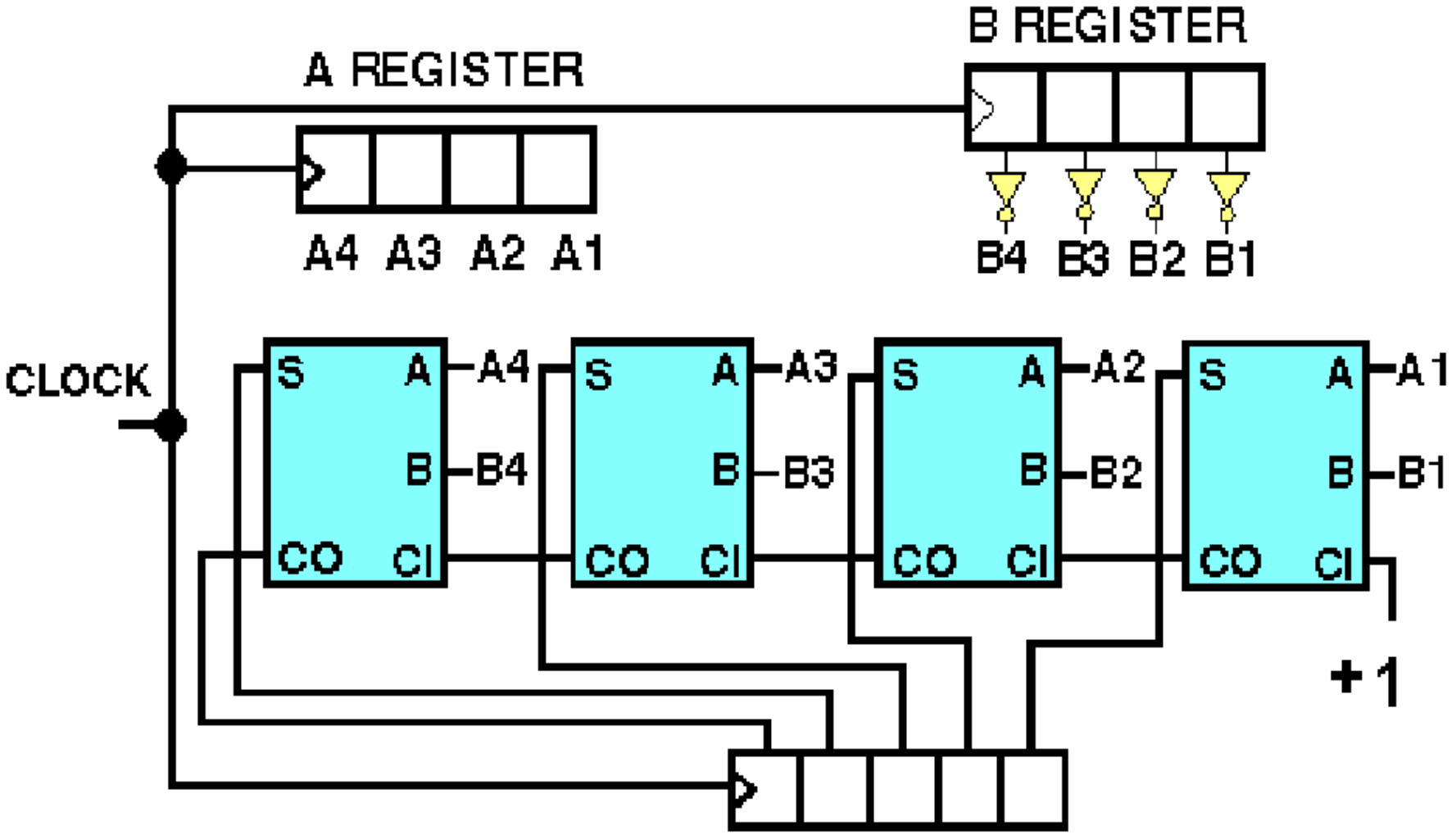




SUBTRACTOR TWO'S COMPLEMENT



4 BIT SERIAL SUBTRACTOR



4 BIT PARALLEL SUBTRACTOR

EL15-S31

The ADDER which does not use the carry from a previous circuit is the

1. full adder.

2. part adder.

3. half adder.

4. whole adder.

How is the 1's complement changed to a 2's complement in a subtractor circuit ?

1. Placing a low on the CO input
2. Placing a high on the CO input
3. Placing a low on the CI input
4. Placing a high on the CI input

The result of inverting a number and adding one is called the

1. Subtractor
2. Subtrahend
3. Minuend
4. Two's complement

ENABLING LEARNING OBJECTIVE 3

ACTION

Complete CAI lessons on Ripple, Up/Down Counters and Adder and Subtractor circuits.

CONDITION

Given a classroom environment, Computer Aided Instruction (CAI) workstation, NIDA 130 Electronic Trainer, Digital Multimeter w/test leads, Digital Logic Probe, PC130-111, PC130-116, PC130-121, PC130-131, and official OMEMS reference material.

STANDARD

Correctly answer 18 of 25 questions concerning arithmetic units.

Enabling Learning Objective 4

Troubleshoot Arithmetic Units circuits, given equipment and reference answer a minimum of 70% questions correctly.

ENABLING LEARNING OBJECTIVE 4

ACTION

Perform troubleshooting procedures on arithmetic units.

CONDITION

Given a classroom environment, Computer Aided Instruction (CAI) workstation, NIDA 130 Electronic Trainer, Digital Multimeter w/test leads, Digital Logic Probe, PC130-111, PC130-116, PC130-121, PC130-131, and official OMEMS reference material.

STANDARD

Correctly identify 10 of 10 malfunctions in arithmetic units.